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(54) Signal conversion method and video tape recorder employing the same method

(57) In order to record a teletext signal using a domestic video tape recorder, the received teletext signal *a*, *b* is converted to a further signal *c*, *d* having a lower data transmission rate than that of the received teletext signal. The further signal is added to the video signal in the vertical blanking interval thereof and a clock signal corresponding to the lower rate is added to each horizontal line interval in which the further signal is added when the further signal is recorded. Preferably, a framing code corresponding to the lower rate is also added. A video tape recorder for carrying out this procedure includes a random access memory whose reading and writing operations are controlled to provide the rate reduction.

FIG. 4

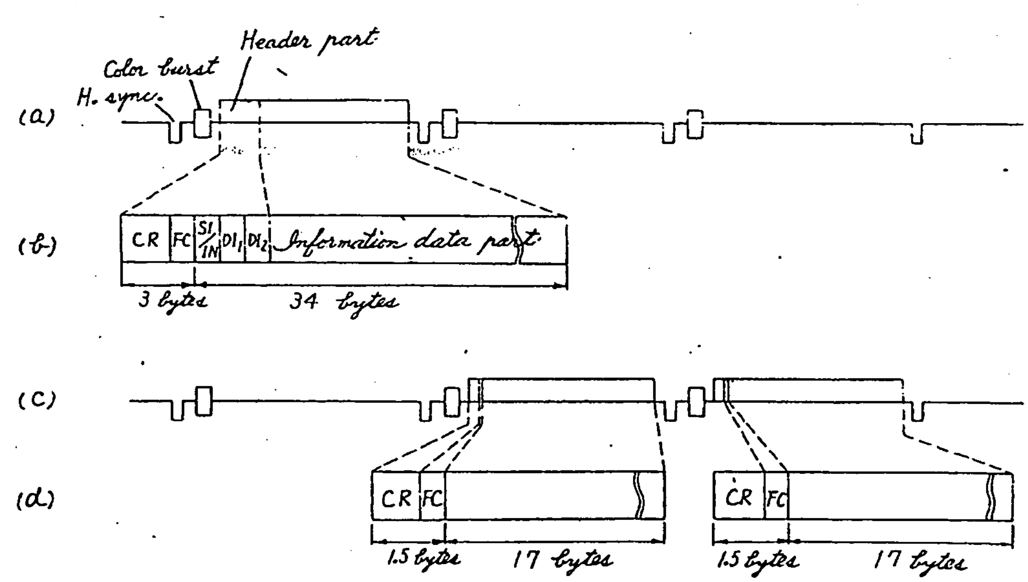

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FIG. 1

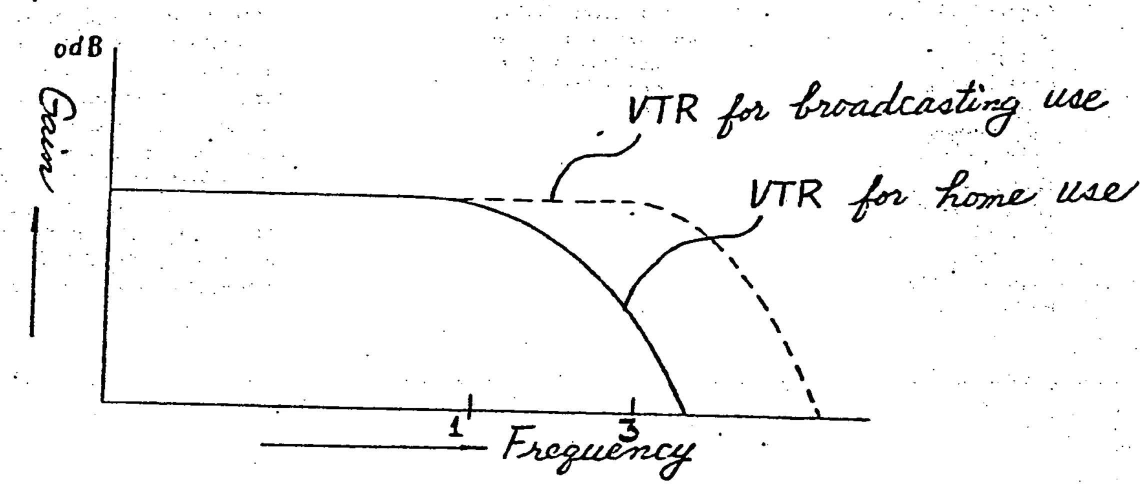

odB
Gain
VTR for broadcasting use
VTR for home use
1
3
Frequency

FIG. 2

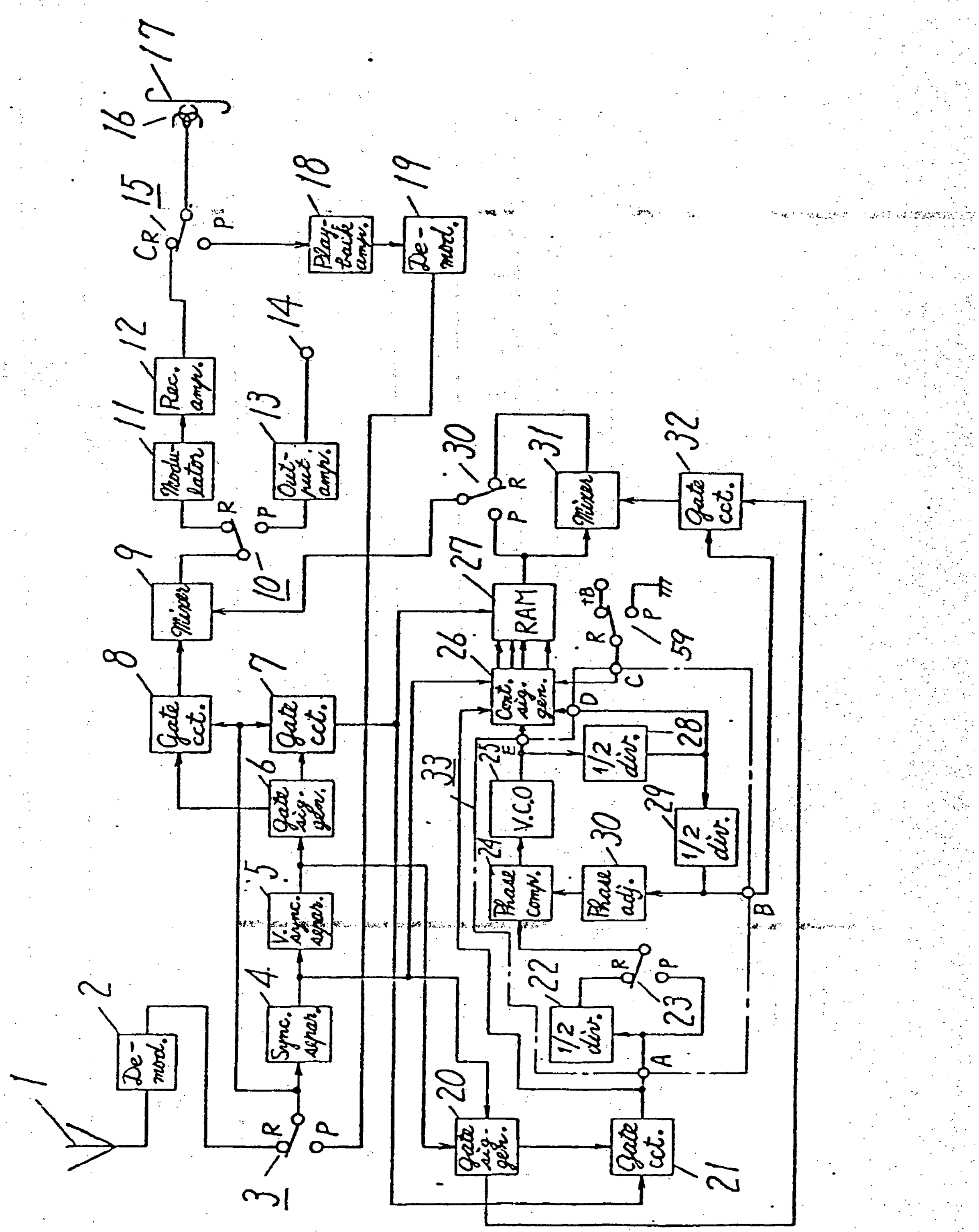
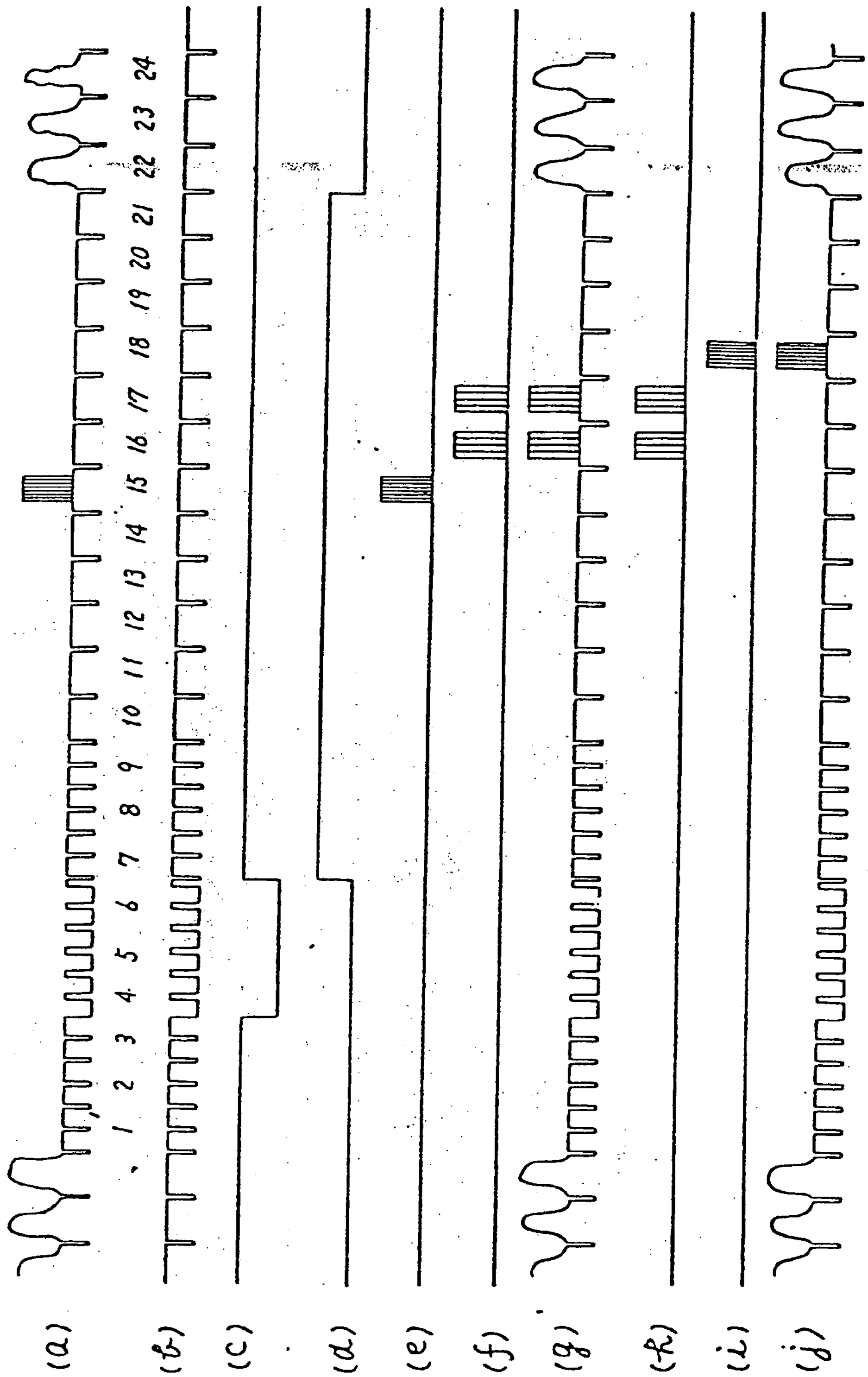

De-mod.
Sync. separ.
V. sync. sig. separ.
Gate sig. gen.
Gate cct.
Mixer
Modulator
Rec. amp.
Output amp.
Play-back amp.
RAM
Cont. sig. gen.
V.C.O
Phase comp.
Phase adj.
1/2 div.

FIG. 3



2132856

FIG. 4

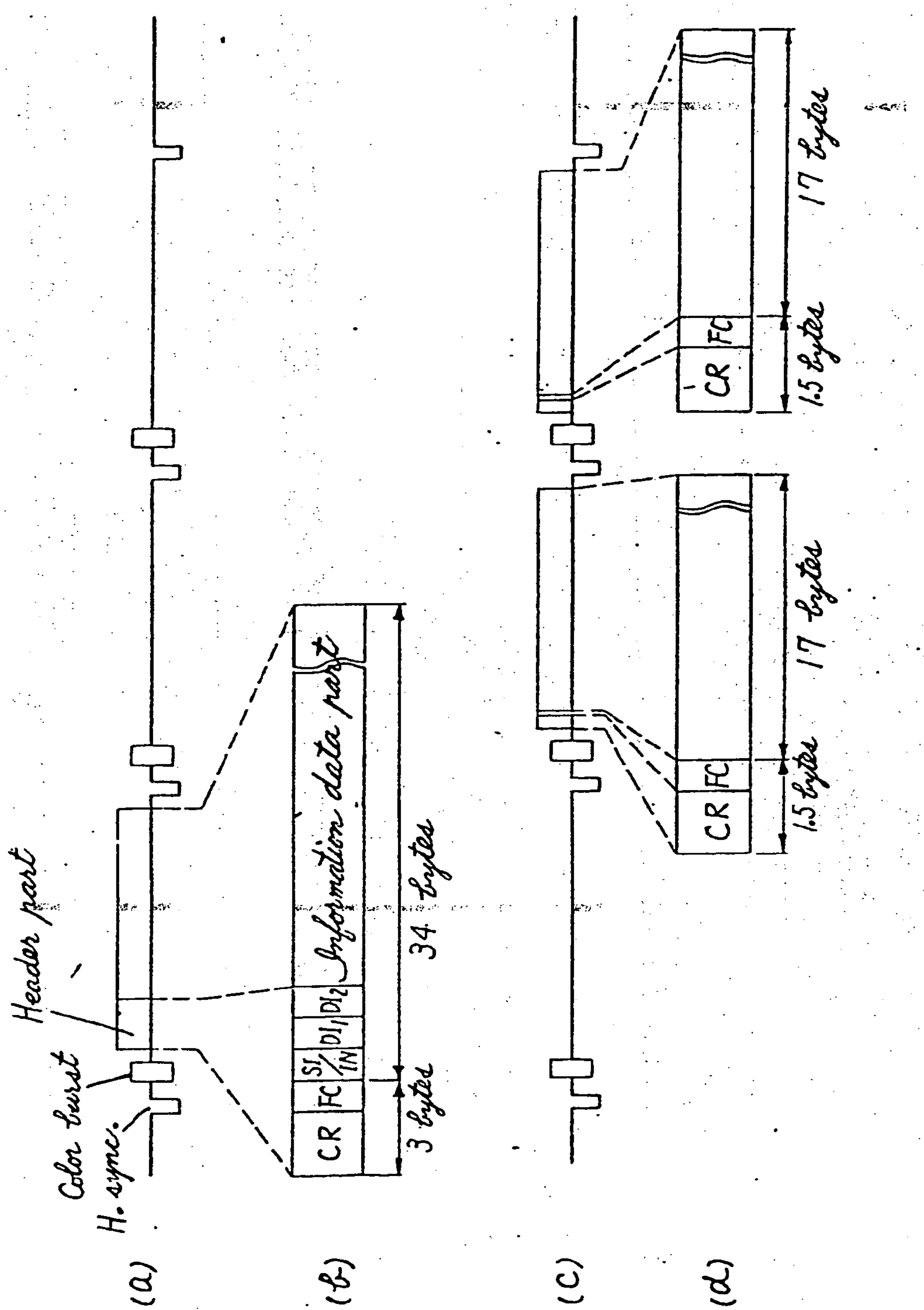


FIG. 5

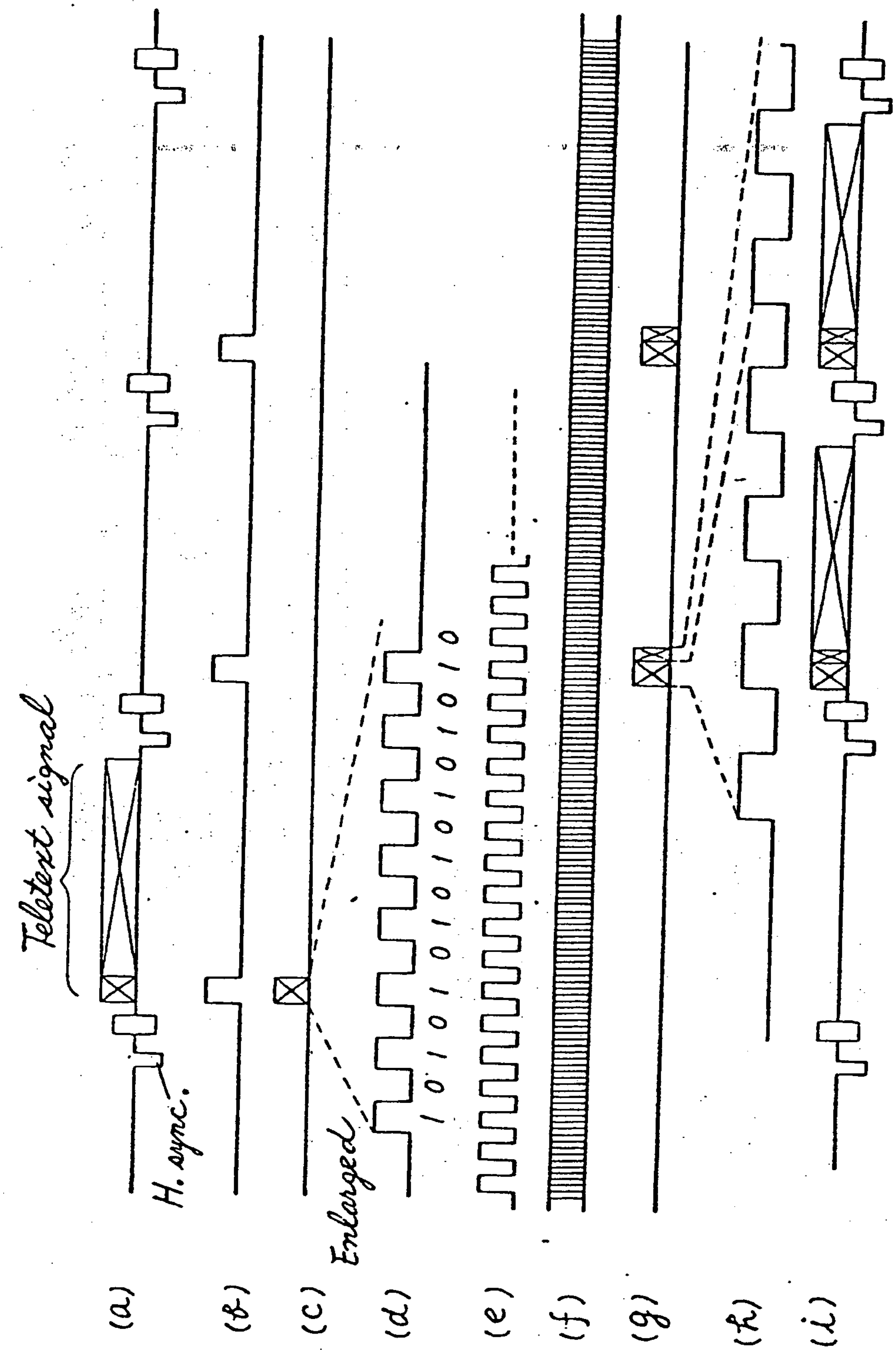

Teletext signal
H. sync.
Enlarged
1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0
(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)

FIG. 6

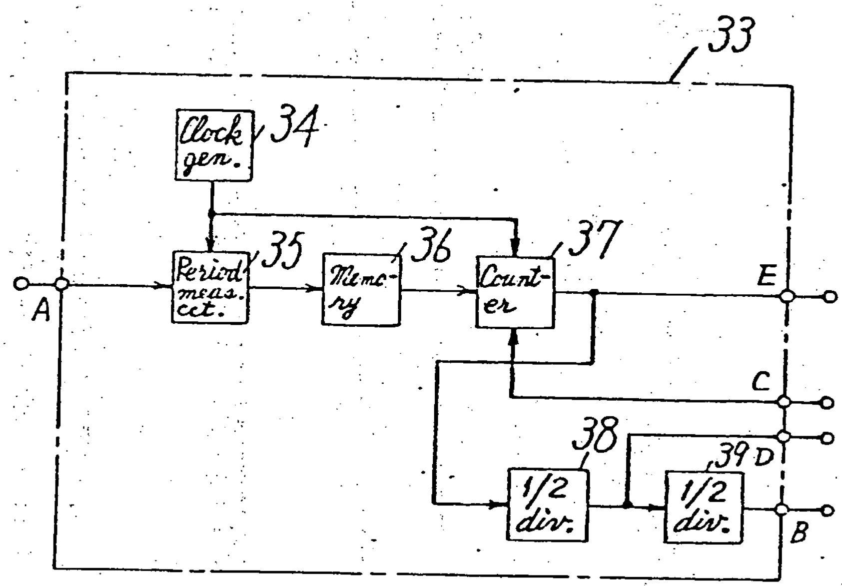

33
Clock gen.
34
Period meas. cct.
35
Memory
36
Counter
37
A
E
C
38
1/2 div.
39
D
1/2 div.
B

FIG. 7

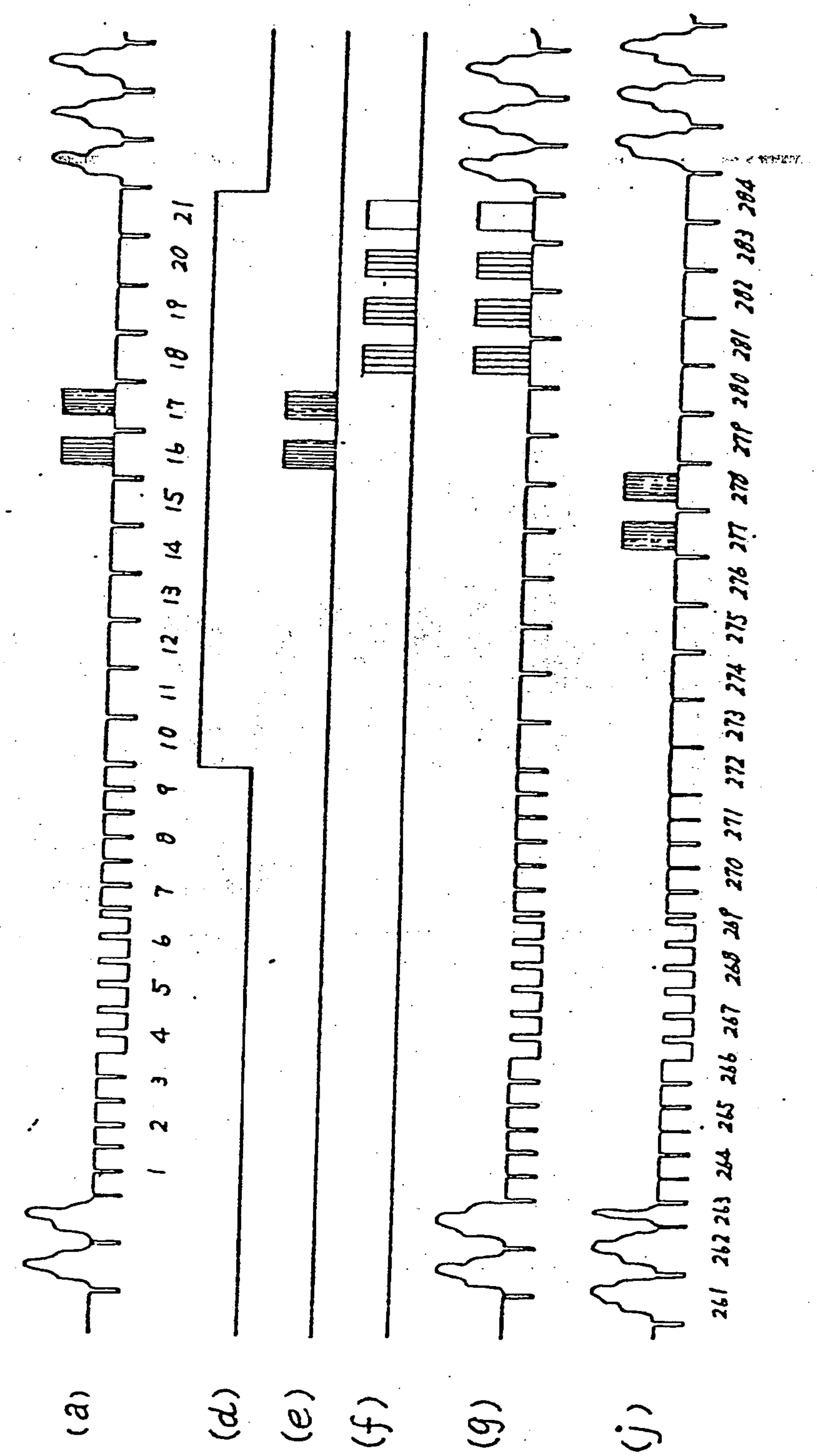
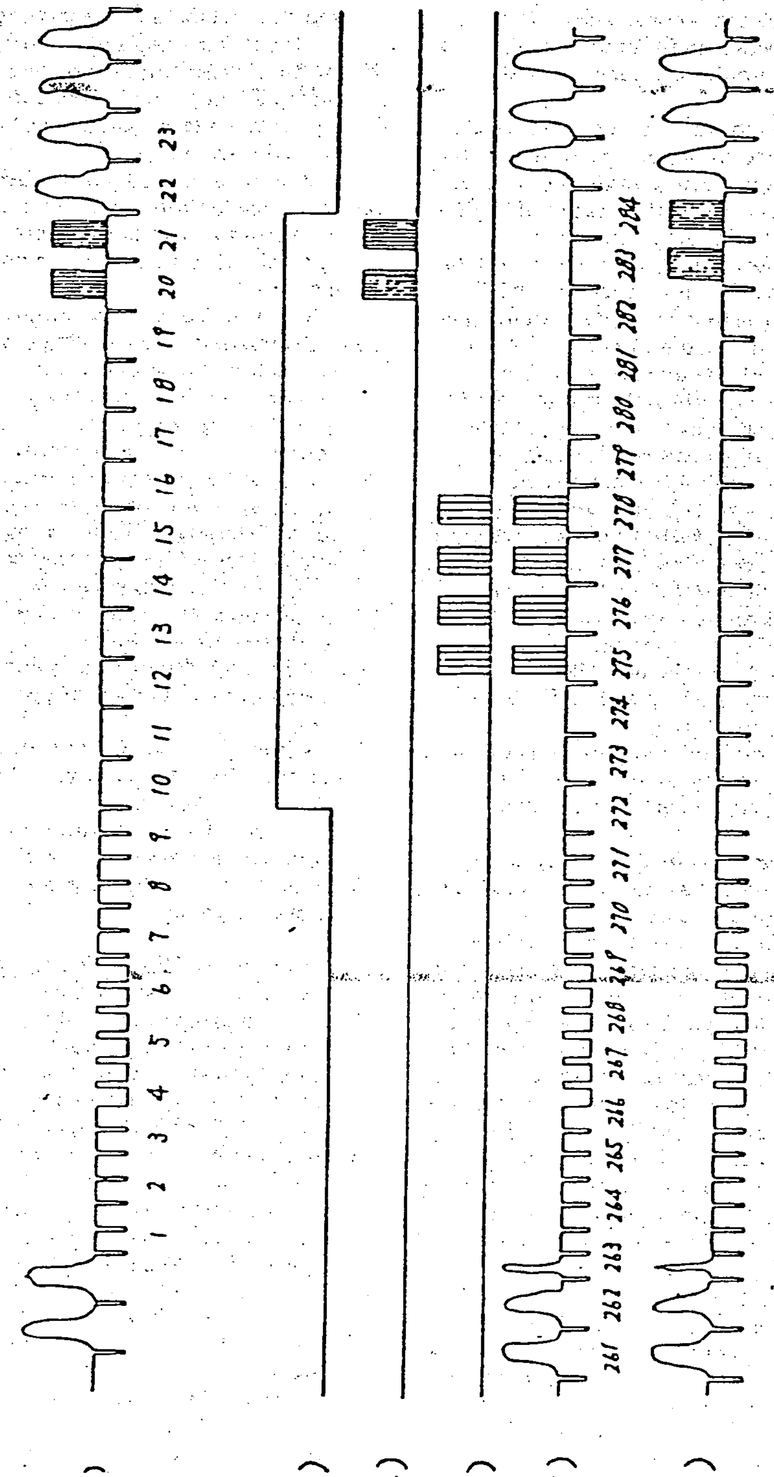

(a)
(d)
(e)
(f)
(g)
(j)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284

FIG. 8


(a)
(d)
(e)
(f)
(g)
(j)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284

SPECIFICATION

Signal conversion method and video tape recorder mploying the same method

The present invention relates to a signal conversion method for preventing teletext signals from being deteriorated when they are recorded and reproduced in video tape recorders for domestic use, and a video tape recorder employing such a signal conversion method.

Video tape recorders (hereinafter referred to as a "VTR") for domestic use have poorer signal-to-noise ratios and frequency characteristics during recording and reproducing processes than those of VTRs used in broadcasting stations. For example, a domestic VTR has a frequency band curve as shown in Figure 1 of the accompanying drawings which is substantially flat up to as high as 1 MHz, but the gain drops above 1 MHz and drops more than 20 dB at 3MHz whereas the VTR for broadcasting use has a frequency band curve which is still substantially flat.

For teletext broadcasting in Japan, 5.73 MHz (= 364 fH, fH : horizontal synchronising frequency) has been assigned as a transmission clock frequency, and the maximum transmission frequency required for character signals is 2.86 MHz. When such signals are recorded and reproduced in a domestic VTR, reproduced output signals or teletext signals have a considerably low level and are largely distorted with a poor signal-to-noise ratio. Therefore, it is substantially impossible for such domestic VTRs to record and reproduce teletext signals due to attenuated signal levels at such a frequency.

It is an object of the present invention to prevent signals such as teletext signals from being deteriorated when they are recorded and reproduced in VTRs.

According to a signal conversion method of the present invention, a teletext signal is extracted from a composite image signal of a base band on reception of broadcast signal, and is converted into a teletext signal having a lower transmission rate than a normal transmission rate. The teletext signal is then divided into signals which are added to some horizontal lines in a vertical blanking interval of the video signal. When the signals are added, a clock signal which corresponds to the teletext signal of the slower rate is added to the signal in each horizontal line. When the teletext signal is to be reproduced, the signal is converted back into the teletext signal at the normal rate to emply signals added to a reproduced video signal as a video signal output.

A video tape recorder according to the present invention comprises a gate circuit for extracting a teletext signal from a vertical blanking interval a composite video signal obtained by demodulating a received broadcast signal, a random-access memory, and a control signal generator for generating a control signal for controlling reading and writing operations of the random-access memory. The control signal is generated from a clock signal contained in the teletext signal and a synchronising signal of the video signal. In a recording mode, the control signal is written into the memory at a normal transmission rat and read out of the memory at a rate lower than the normal transmission rate, and an obtained teletext signal is recorded on a recording medium while being added in the vertical blanking interval of the original video signal. In a playback mode, the teletext signal of the lower rate added in the vertical blacking interval of the video signal reproduced from the recording medium is extracted by the gate circuit, and a control signal is generated by the control signal generator based on a synchronising signal in the reproduced signal and a clock signal in the teletext signal of the lower rate. The reproduced teletext signal is written into the memory circuit and read out thereof at the normal transmission rate. The teletext signal thus obtained is delivered as an output while being added in the vertical blanking interval of the reproduced video signal.

The above and other features and advantages of the present invention will become more apparent from the following description when taken in conjunction with the accompanying drawings in which preferred embodiments of the present invention are shown by way of illustrative example.

Figure 1 is a diagram showing difference frequency characteristics of video signals recorded and reproduced by a VTR for domestic use and a sophisticated VTR for broadcasting or industrial use;

Figure 2 is a block diagram of a VTR capable of recording and reproducing teletext signals according to the present invention;

Figures 3, 4 and *5* are diagrams showing signal waveforms illustrative of conversion of character signals;

Figure 6 is a block diagram of an arrangement, different from that shown in Figure 2, for generating a clock signal; and

Figures 7 and *8* are diagrams showing the waveforms of converted character signals generated when recording and reproducing a plurality of teletext signals.

Description of the preferred embodiments

As shown in Figure 2, a carrier television signal received by an antenna 1 is demodulated by a demodulator 2 into a composite video signal shown at *a* in Figure 3. The demodulated video signal is supplied to a synchronising separator 4 and gate circuits 7, 8 through a switch 3 for selecting recording and playback modes, the switch 3 having a recording contact R and a playback contact P. The synchronising separator 4 serves to extract a synchronising signal of a video signal shown at *b* in Figure 3 from the supplied composite video signal. The signals shown at *a, b* in Figure 3 are in the vicinity of the vertical blanking interval of an odd-numbered field, and a teletext signal is added anywhere between 10th H and 21st H in the vertical blanking interval (an even-numbered field, betwe n 273rd H and 284th H: H being one horizontal synchronising signal interval). A teletext signal is shown as being added to the 15th H.

The synchronising signal produced by the synchronising separator 4 is applied to a vertical synchronising separator 5, a gate signal generator

20, and a control signal generator 26.

The vertical synchronising separator 5 serves to extract a vertical synchronising signal from the synchronising signal and produces an output as shown at *c* in Figure 3. The output signal from the vertical synchronising separator 5 is applied to gate signal generator 6, 20.

The gate signal generator 6 produces a gate signal for producing the teletext signal from the composite video signal. The gate signal generator 6 comprises a monostable multivibrator, for example, for generating a gate signal as illustrated at *d* in Figure 3 by using the vertical synchronizing signal as a trigger signal. The gate signal is supplied to the gate signal 7. The gate signal generator 6 also issues a gate signal having a polarity opposite to that of the gate signal d in Figure 3 to the gate circuit 8. Since the gate circuit 7 is supplied with the composite video signal containing the teletext signal from the demodulator 2, the gate 7 picks up the teletext signal only as shown at e in Figure 3 in response to the gate signal applied from the gate signal generator 6. The gate circuit 7 includes a clipping circuit for removing the synchronizing signal when the teletext signal is extracted from the video signal.

Since the gate circuit 8 is fed with the gate signal of the opposite polarity, it produces the video signal only with the teletext signal removed therefrom. The teletext signal issued from the gate circuit 7 is stored temporarily in a random-access memory (hereinafter referred to as a "RAM") 27 which is supplied with a control signal such as an addressing signal from a control signal generator 26.

The control signal generator 26 will now be described in detail. As shown at *a*, *b* in Figure 4, the teletext signal is composed of a header part and an information data part. The header part has a clock run-in (CR) signal, a framing code (FC), a service identification and interrupt control (SI/IN) signal, and a data identification (DI) code. A clock serving as a reference for reading data must be generated from the clock run-in signal.

The control signal for the RAM 27 is generated on the basis of the clock run-in signal.

The clock run-in signal is extracted by a gate circuit 21 from the teletext signal issued from the gate circuit 7. A gate signal is issued from the gate signal generator 20 to the gate circuit 21. Since the gate signal generator 20 is supplied with the synchronizing signal from the synchronizing separator 4 and the vertical synchronizing signal from the vertical synchronizing separator 5, the gate signal generator 20 produces the gate signal as shown at b in Figure 5 based on the supplied signals. Figure 5a shows on an enlarged scale a signal portion of the signal illustrated in Figure 2a which contains the teletext signal. The gate circuit 21 is thus responsive to the gate signal for generating the clock run-in signal as shown at *c*, *d* in Figure 5. As shown at d in Figure 5, the clock run-in signal is composed of eight pulses. The clock signal has a frequency twice that of the clock run-in signal. Therefore, the clock run-in signal is equivalent to a data signal representative of "1010101010101010", and the clock signal for reading such a data signal must be in the form as shown at e in Figure 5. Therefore, the clock run-in signal shown at d in Figure 5 forms the basis for generating the clock signal illustrated at e in Figure 5.

An arrangement for producing such clock signal will be described. The clock run-in signal generated from the gate circuit 21 is applied to divide-by-2 frequency divider 22 which generates a signal having a period twice that of the signal shown at d in Figure 5. The signal generated by the frequency divider 22 is fed via a contact R of a switch 23 to a phase comparator 24 supplied with a signal produced by reducing the frequency of an output from a voltage-controlled oscillator 25 to 1/4. More specifically, the output from the voltage-controlled oscillator 25 is delivered through two divide-by-2 frequency dividers 28, 29 so that the frequency will be reduced to 1/4. The frequency-divided output is brought into phase with the clock run-in signal by a phase adjuster 30, so that the clock signal will be generated by the voltage-controlled oscillator 25, because, provided the clock signal has a frequency fc, the frequency of the clock run-in signal is 1/2 fc, and the signal from the divided-by-2 frequency divider 22 has a frequency 1/4 fc.

Though the signal entering the phase comparator 24 is composed of four pulses, the phase can be maintained at constant for an interval of several Hs by holding an error signal produced thereby. While in the illustrated embodiment a PLL (Phase-Locked Loop) circuit 33 is employed, a circuit arrangement shown in Figure 6 may equally be utilized.

Input and output signals applied to and produced from circuits enclosed by the dot-and-dash lines in Figures 2 and 6 are remain the same. The signals applied to and issued from the terminals denoted by the identical letters are identical. The circuit arrangement shown in Figure 6 will be described. The clock run-in signal is applied through the terminal A to a period measuring circuit 35, which is supplied from a clock generator 34 with a clock signal having a frequency several hundreds higher than that of the clock run-in signal for keeping any error in period measurement down to 1 % or below. The measuring accuracy may be increased by measuring all of the 16 pulses of the clock run-in signal. The count of periods is then stored in a memory 36, and the stored count is set in a counter 37. The counter 37 counts clock pulses from the clock generator 34, issues a pulse each time the count reaches a set value. Therefore, the counter 37 can produce a clock signal in synchronism with the clock run-in signal. A signal equal to the clock run-in signal can be produced by dividing the frequency of the clock signal from the counter 37 with a divide-by-2 frequency divider 38, and a clock signal for recording (described later) can be generated by further dividing the frequency of the signal from the divide-by-2 frequency divider 38 with another divide-by-2 frequ ncy divid r 39.

The clock signal generat d by the voltage-controlled oscillator 25 (Figure 2) or the counter 37 (Figure 6) is applied to the control signal generator 26, which is supplied with the clock run-in signal from the gate circuit 21, the synchronizing signal from the synchronizing separator 4, and a selected

DC voltage from a switch 59 for selecting recording and playback modes. According to the illustrated embodiment, a DC voltage + B is applied to the control signal generator 26 from the switch 59 only in the recording mode. This is just for the sake of convenience, and the DC voltage + B may not be applied in the recording mode. The control signal generator 26 is also supplied with a signal obtained by frequency-dividing the clock signal with the divide-by-2 frequency divider 28. In response to the supplied signals, the control signal generator 26 generates a control signal for storing the teletext signal shown at e in Figure 3 into the RAM 27 by utiizing the clock signal from the voltage-controlled oscillator 25 and the clock run-in signal serving as a head signal for the signal storing operation. The teletext signal stored in the RAM 27 is read out of the RAM 27 as a clock signal of low rate as shown at f in Figure 3, which is then added and recorded in the vertical blanking interval as illustrated at g in Figure 3. In the embodiment, the signal that has been on one line is expended into signals on two lines which are added as shown at g in Figure 3. The signal is read out of the RAM 27 at a rate half the speed at which the signal has been stored into the RAM 27.

As illustrated in Figures 4 at *a* and *b*, the teletext signal is also composed of data of 37 bytes. There are various methods available for expanding the data on a time basis for two blocks. Figure 4 shows one example of such expansion method. The clock run-in (CR) signal and the framing code (FC) do not constitute data, and the remaining signal part of 34 bytes is the necessary information data. By dividing this information data into halves, each data half contains 17 bytes. To the head of each 17-byte data, there are added a clock run-in (CR) signal and a framing code (FR) signal which are newly produced and of 1.5 bytes as shown in Figure 4 at *c*, *d*. Thus, a teletext signal is generated which has the same time interval as that of the original teletext signal, with the frequency being half that of the latter. Therefore, the clock signal for reading the data out of the RAM 27 at a half rate can be produced from the output from the divide-by-2 frequency divider 28 and the synchronizing signal.

To the clock run-in signal and the framing code signal as shown at *c*, *d* in Figure 4 are added the signal obtained by reducing the frequency of the clock signal to 1/4 with the divide-by-2 frequency divider 29. The framing code is of four bits though it is composed of eight bits of 11100101 in the original teletext signal. Since the framing code is a code utilized within the VTR only, it may be the same as the clock signal or the original framing code may be divided into halves with a first line being 1110 and a second line 0101. Th clock run-in signal and the framing code signal are added to the frequency-divided signal from the divide-by-2 frequency divider 29 by a gate circuit 32, and then is mixed with a signal from the RAM 27 by a mixer 31. A gate signal for the gate circuit 32 is produced by the gate signal generator 20 and is longer by the framing code signal than the gate signal shown at b in Figure 5. Figure 5 shows at f a successive clock signal (output from the divide-by-2 frequency divider 29) which has been frequency-divided into 1/4, and Figure 5 shows at *g* clock run-in signals and framing pulses employed in the VTR in the recording mode. Figure 5 shows a clock run-in signal and a framing pulse on an enlarged scale. An output from the mixer 31 is then delivered through a contact R of a stich 30 to a mixer 9. Since the mixer 9 is supplied with the video signal with no teletext signal from the gate circuit 8, the mixer 9 issues a signal shown at *g* in Figure 3 (the signal g shown on an enlarged scale in Figure 5 at *i*). The signal from the mixer 9 is delivered through a contact R of a switch 10 to a modulator 11 in which the signal is frequency-modulated. The frequency-modulated signal is then amplified by a recording amplifier 12, which issues an amplified signal through a contact R of a switch 15 to a magnetic head 16 for being recorded on a magnetic tape 17. In reality, the VTR incorporates a rotary head for recording the signal on the magnetic tape 17. Since the present invention has no particular bearing on the rotary head, the mechanical parts in the VTR will not be described.

A playback mode for playing back the magnetic tape 17 on which the video signal including the teletext signal will now be described.

The video signal as reproduced by the magnetic head 16 is delivered through the switch 15, amplified by a playback amplifier 18, and applied to a demodulator 19. The demodulator 19 serves to demodulate the frequency-modulated signal and issues a signal which is the same as the recorded video signal (as shown at *g* in Figure 3). The demodulated signal is applied through the contact P of the switch 3 to the synchronizing separator 4 and the gate circuits 7, 8, which process the signal in the same manner as that in the recording mode.

The signal contains a teletext signal having a low bit rate, which cannot be played back as a normal teletext signal on a television receiver having a teletext-signal-reception capability.

In order for such a signal to be properly received by the television receiver, the signal must be converted into a teletext signal having a normal bit rate. A method of such such signal conversion will be described hereinbelow.

Unlike the recording mode, the control signal generator 26 produces a writing control signal based on the frequency-divided signal from the divide-by-2 frequency divider 28. The signal stored in the RAM 27 is read out of the RAM 27 at the same rate as that of the original teletext signal as shown at *i* in Figure 3. The teletext signal as read out of the RAM 27 is delivered through a contact P of the switch 30 to the mixer 9. Since the mixer 9 is fed with the video signal with no teletext signal from the gate circuit 8, the mixer 9 produces an output signal as shown at j in Figure 3. The signal from the mixer 9 is then delivered through the contact P of the switch 10 and an output amplifier 13 to an output terminal 14. A television r ceiver with a tel text-signal-reception capability is connected to th output terminal 14 for displaying an image based on the reproduced teletext signal.

The control signal generator 26 will be described in greater d tail. The signal for selecting the record-

ing mode R and the playback mod P is applied to the control signal generator 26 for effecting the signal storage into the RAM 26, the signal storage for the signal reading, and the directing of the signal reading rate. More specifically, in the recording mode, the signal is stored on single line at a normal character signal transmission rate, and thereafter read out over two lines at a rate half the normal character signal transmission speed. In the playback mode, the reproduced character signal is stored over two lines at a rate half the normal character signal transmission speed, and read out at the normal character signal transmission speed.

The framing code may be of a format peculiar to the VTR in the recording mode as described above. In the playback mode, however, the RAM 27 or other processing circuit is attached to produce the foregoing framing code, 11100101. Alternatively, 1110 and 0101 may be recorded respectively on two lines, and they may be added together to produce a framing code.

While in the foregoing embodiment the clock run-in signal and the framing code signal comprise 1.5 bytes as desired.

Figure 7 shows teletext signals added in 16th H and 17th H, and Figure 8 illustrates teletext signals added in 20th H and 21th H. The signals *a* through *j* shown in Figures 7 and 8 correspond respectively to those in Figure 3. When a plurality of teletext signals are added, the mixer 9 produces a signal shown at *j* in Figures 7 and 8 in the playback mode. These teletext signals in the reproduced video signals are positioned differently from those prior to being recorded. This is because the RAM needs storage and reading times. Such positional or phase differences however do not affect the decoding of teletext signals in the television receiver.

It is not determined in which lines (H) teletext signals will finally be incorporated. Two examples will be described. The example shown in Figure 7 indicates that teletext signals are incorporated in 16th H and 17th H. By reducing the transmission speed by half in the recording mode by the method as shown in Figure 3, teletext signals are incorporated in 18th, 19th, 20th, and 21st H, located at the end of a vertical blanking interval provided for by the standards. The character signals thus converted produce a video signal as shown at *g* in Figure 7 which will be recorded. The reproduced video signals remain the same as that shown at g in Figure 7. If the reproduced character signals were converted into those having the original bit rate in the same manner as described above with reference to Figure 3, the teletext signals would be positioned in 22nd and 23rd H in alignment with the video signal. To avoid this, the character multiplexing signals are brought into a next field. Figure 7 shows at *j* the telextext signals in 277th and 278th H in an ven-numbered field. Though the signals are delayed about 1 field from the original position, the delay will not be detected when the signals are decoded and displayed.

Figure 8 shows at a that character signals are incorporated in 20th and 21st H. In this instance, no signal of low rate cannot be brought subsequently to the 21st H in the recording mod , and hence the signals are delayed into a next field as shown at *f, g* in Figure 8. Since these signals are reproduced in the same position, the original teletext signals are added in 283rd and 284th H in an even-numbered field. The 1-field delay caused at this time also poses no problem. Naturally, the character signals which have originally been in an even-numbered field are delayed into a next succeeding odd-numbered field.

The three examples including the example of Figure 3 have been described. Signals can be recorded at a much lower rate in instances wherein there are more programs and a lower rate is required. Various combinations can therefore be possible, but the principles remain the same as described above, and such modifications are within the scope of the present invention.

As described above, the signal frequency recorded is half that of the original signal. Since the video frequency currently proposed in the teletext broadcasting system is 2.86 MHz, as described above, its half frequency is 1.43 MHz, which can sufficiently be recorded and reproduced on home VTRs without suffering from signal deterioration.

A signal conversion method of the present invention is capable of preventing teletext signals from being deteriorated when they are to be recorded or reproduced on a small-size VTR for home use. The teletext signals can be recorded and reproduced with high fidelity by employing a simple memory circuit. By adding a special clock in the VTR, stable character signals can be transmitted in the VTR. Any influence due to variations in the speed of the magnetic tape and the rotation of a motor in the VTR can also be eliminated. Thus, the present invention has many industrial advantages.

CLAIMS

1. A method of signal conversion comprising the steps of converting a received normal teletext signal A into a teletext signal B having a lower rate than a normal transmission speed, adding said teletext signal B in a vertical blanking interval of a video signal, and adding a clock signal corresponding to said lower rate to each horizontal line in which said signal B is added when the signal B is to be recorded on a recording medium.

2. A method according to claim 1, wherein a framing code corresponding to the lower rate is added to each horizontal line.

3. A video tape recorder comprising means for converting a teletext signal contained in a composite video signal into a signal having a lower rate than a normal transmission rate, means for adding the conv rted signal in a vertical blanking interval of the video signal and recording the signal on a recording medium, means for converting the teletext signal of the lower rate contained in the video signal as reproduced from said recording medium into a signal having the normal transmission rate, and means for adding the last-mentioned converted signal in a vertical blanking interval of the reproduced video signal to produce a video signal output.

4. A video tape recorder comprising a gate circuit

for extracting a teletext signal added in a vertical blanking interval from a composite video signal of a base band obtained by demodulating a received broadcast radio wave, a random-access memory, and a control signal generator for generating a control signal for controlling reading and writing operation of the random-access memory, the arrangement being such that the control signal is generated by said control signal generator from a clock signal contained in the teletext signal and a synchronizing signal of the video signal, that, in a recording mode, the control signal is written into said memoery at a normal transmission rate and read out of the memory at a rate lower than the normal transmission rate, and an obtained teletext signal is recorded on a recording medium while being added in the vertical blanking interval of the original video signal, and that, in a playback mode, the teletext signal of the lower rate added in the vertical blacking interval of the video signal reproduced from the recording medium is extracted by said gate circuit, and a control signal is generated by said control signal generator based on a synchronizing signal in the reproduced signal and a clock signal in the teletext signal of the lower rate, and the reproduced teletext signal is written into the memory and read out thereof at the normal transmission rate, the teletext signal thus obtained being delivered as an output while being added in the vertical blanking interval of the reproduced video signal.

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